



Agricultural Research Institute, Pusa

---

# THE MILLING AND BAKING QUALITY OF INDIAN WHEATS

BY

ALBERT HOWARD, M.A. (Cantab.), A.R.C.S. (Lond.), F.C.S., F.L.S.,  
Imperial Economic Botanist

AND

GABRIELLE L. C. HOWARD, M.A.,  
Associate and late Fellow of Newnham College, Cambridge



CALCUTTA  
SUPERINTENDENT GOVERNMENT PRINTING, INDIA  
1908



## THE MILLING AND BAKING QUALITIES OF INDIAN WHEAT.

---

IN order to obtain an accurate opinion of the breadmaking value of a variety of wheat, it is necessary to have it ground into flour and made into bread. In spite of much recent work on the chemistry of wheat and of wheat flour, no safe deductions as to its value to the baker can be obtained from the results of chemical analysis. The most that can be said at present is, that, *as a rule*, wheats high in total nitrogen give the *strongest* flours, that is to say "flours with a capacity for making large well-shaped loaves" (Humphries and Biffen).<sup>1</sup> There are however exceptions to this rule and we must rely on the opinion of the miller and baker for the final verdict on any particular variety.

It is possible to get an accurate opinion on any wheat from a sample of about 60 lbs. in weight. This quantity enables an expert miller, with the necessary apparatus, to give an opinion on the milling qualities of the wheat, the character of the flour and also to carry out baking tests in duplicate. The recent investigations in England of the Home-grown Wheat Committee of the Incorporated National Association of British and Irish Millers, have led to the perfecting of a combined milling and baking test for 60 lbs. samples which has been found to yield exceedingly accurate results. The object of this Committee is the improvement of the strength of English wheats, a quality in which the wheats at present grown in Great Britain are notably deficient. Numerous samples of introduced and other wheats have had to be tested and this led to the perfecting of a method of testing which was found to yield results of practical value.

Accordingly we approached Mr. A. E. Humphries, the Chairman of the Home-grown Committee in England who is in charge of the work there with a view of securing his assistance with regard to the wheats of India. We were fortunate in securing his co-operation in the matter and his report on the samples submitted by us in 1908 is given

---

<sup>1</sup> *Humphries and Biffen*.—The Improvement of English Wheat.—*Jour. Agr. Sc.*, Vol. 2, part 1, January 1907.

below. This report speaks for itself, and we consider that it marks an important advance in the wheat production of India which will ultimately prove of material advantage to the country. As Mr. Humphries is an English miller and a large purchaser of Indian wheat, his report is of particular interest and value to this country.

The milling and baking tests dealt with in this paper are not the first that have been carried out with Indian wheats. Following the opening of the Suez Canal and the action of the Government of India in 1873, in freeing Indian wheat from all export duty, the foreign trade in Indian wheat rapidly increased in importance and the question of its improvement early engaged the attention of the Secretary of State and of the Government of India. Samples of Indian wheat, about 1,000 in number, were called for in 1877, and these were examined in London by Forbes Watson<sup>1</sup> and Cooke.<sup>2</sup> The necessity for a complete milling and baking test of representative samples of Indian wheat was pointed out by Forbes Watson and accordingly this was undertaken by Messrs. MacDougal Brothers in London in 1882.<sup>3</sup>

The four samples sent for milling and baking were as follows:—

- (1) Soft white from the Meerut and Muzaffernagar districts.
- (2) Soft red from the Meerut district.
- (3) Hard red from the Banda district of Bundelkhand.
- (4) Hard white from Khandesh in Bombay.

The four above mentioned parcels were milled by Messrs. MacDougal Brothers by the then ordinary process of grinding under millstones and also by the Hungarian or roller system which was at that time a novelty in Great Britain. Comparisons were made with English, American, Australian, Russian, and Egyptian sorts both in the mill and subsequently in the bakehouse.

It is clear from the report that the hard red and hard white wheats sent from India were macaroni and not bread wheats and are not usually

<sup>1</sup> *Forbes Watson*.—Report on Indian Wheat (C-2318). Eyre and Spottiswoode, London, 1879 (Reprinted in *The Wheat Production and Trade of India*.—Selections from the records of the Government of India, Home, Revenue and Agricultural Department, No. CLX, Simla, 1879).

<sup>2</sup> *Cooke, M. C.*—Supplemental Report on Indian Wheat.—*Wheat Production and Trade of India*, Calcutta, 1883.

<sup>3</sup> Report on Indian Wheats by MacDougal Bros.—*Wheat Production and Trade of India*, Calcutta, 1883.

exported to England for baking purposes. The soft red and soft white wheats were apparently two of the varieties commonly grown in the Delhi, Meerut and Muzaffernagar districts. Messrs. MacDougal state that "there is no probability of the Indian wheats coming into demand for manufacture into flour without a liberal admixture of other wheats. They all possess in a marked degree the same characteristics of great dryness and a distinct heavy and almost aromatic flavour inseparable from wheats grown in the climates and soils of the tropics. Also the flours are ricey, the texture of the breads is too coarse and the crust is hard and brittle." On the other hand, their great soundness and dryness and the fact that they gave unprecedented yields of flour, ranging from 77.46 to 80.52 per cent., as against English 65.2 and American Spring 72.2, were great points in their favour.

In reading Messrs. MacDougal's report it must be remembered that these milling and baking tests were carried out at a time of transition not only in the development of the milling industry of the United Kingdom but also in the requirements of the modern baking trade. At this period most of the wheat was ground under mill stones for which hard wheats were not in favour partly on account of the wear of the stones caused by the hard grains and partly on account of the difficulty of separating the bran. The advantages of the modern roller mills were then not fully appreciated and with the subsequent changes in milling, due to the present almost exclusive use of roller mills, it was found possible to deal easily with the strong flinty wheats of Hungary, Russia and North America. This in turn led to a rise in the standard of flour strength required by modern bakers. Hence it is not too much to say that the present aspect of the milling and baking industries has been revolutionised both as regards method and material. Hard flinty wheats are now wanted as these mill better in roller mills and give rise to stronger flour than soft starchy wheats and are required to mix with weak flour. Such strong wheats command the highest price in the English market. The colour of the grain is now of little consequence and red wheats are almost as useful as white wheats.

Since the publication in India of the report of Messrs. MacDougal it is interesting to notice that the cultivation of weak soft white wheats of the type of Muzaffernagar has been consistently advocated and in consequence the growth for export of these sorts has increased. The

requirements of the modern milling trade have not been recognised and consequently an idea is prevalent in England that the wheats of India are no stronger than those of the United Kingdom. Thus Humphries and Biffen in a recent paper state<sup>1</sup>: "The fact that India, Australia and California export wheats no stronger than our own, makes it clear that abundance of sunshine does not necessarily result in the production of strong wheat." This is no doubt true of the soft Indian wheats now exported but we do not think it is by any means true of all Indian wheats.

That strong wheats are grown in India seems to have been first discovered by Farrer<sup>2</sup> in 1899 who in a letter to the Revenue Secretary of the Government of India dated August 9th of that year stated:—"On account of the high strength of the flour they produce, I take the liberty of recommending to you for extensive propagation the first two varieties of the three mentioned above for I regard them as the best of all the Indian varieties which thus far have come under my notice. Your Indian varieties appear to vary greatly in the quality of flour strength."

That a mistake in the past in advocating the cultivation for export of soft wheats has been made, will be clear on reading the following report on the ten samples of Indian wheat sent by us to England for milling and baking tests after the harvest of 1908. The wheats sent were as follows:—

1. Punjab Type 9 (Lyallpur)—this wheat is known locally as the *lal kala kasar wala*.
2. Lal kasar wala (Lyallpur).
3. Punjab Type 16 (Lyallpur).
4. Australian 27 (Lyallpur)—known also as the *Buggi of Leiah*.
5. Punjab Type 11 (Lyallpur).
6. Gujar Khan (Gujar Khan, Punjab).
7. Pusa 6 (Pusa, Bengal).
8. Muzaffernagar white (Pusa, Bengal).
9. " " (Lyallpur).
10. " " (Muzaffernagar).

<sup>1</sup> *Humphries and Biffen*.—1. c.

<sup>2</sup> Proceedings of the Government of India (Revenue and Agricultural Department, Nos. 1—4, October 1899). These strong wheats came from Etawah and Muzaffernagar in the United Provinces. The Muzaffernagar variety was a beardless wheat.

Numbers 1, 3, 5, 7, 8, and 9 were grown by us at Lyallpur and Pusa. Nos. 2 and 4 came from cultivators' fields at Lyallpur. The Gujjar Khan wheat was obtained in ear from Gujjar Khan and the Muzaffernagar white grown at Muzaffernagar was obtained from a local seed grower in that district. The wheats grown by us were pure cultures. In the rest, ears not true to type were sorted out before threshing.

REPORT BY MR. A. E. HUMPHRIES, PAST PRESIDENT OF THE INCORPORATED NATIONAL ASSOCIATION OF BRITISH AND IRISH MILLERS AND CHAIRMAN OF THE HOME-GROWN WHEAT COMMITTEE OF THE INCORPORATED NATIONAL ASSOCIATION OF BRITISH AND IRISH MILLERS OF THE 10 SAMPLES OF INDIAN WHEATS SENT FROM PUSA IN 1908.

I duly received *via* Calcutta or Karachi the ten sample lots of various wheats grown in India, upon which the Agricultural Department of the Indian Government wished me to report, and in accordance with the arrangement arrived at with you, I have cleaned, conditioned, milled and baked each lot separately and have done each operation in duplicate.

I have regarded the whole matter from the standpoint of a British miller and am accustomed to buy Indian wheats on a commercial basis for the manufacture of flour to be used in England. The methods of milling and baking followed are those which I have used in making a great number of similar tests for the Home-grown Wheat Committee of the National Association of British and Irish Millers.

The 10 samples were designated as follows:—

Red wheats	{	Gujjar Khan.
	{	Punjab Type 9.
	{	Punjab Type 14.
White wheats	{	Pusa 6 grown at Pusa.
	{	Lal Kasar Wala.
	{	Muzaffernagar grown at Lyallpur.
	{	" grown at Muzaffernagar.
	{	Muzaffernagar grown at Pusa.
	{	Australian 27 Lyallpur.
	{	Punjab Type 16.



I do not think that the colour of the husk need be or is likely to be of great importance. British millers are guided in their preferences principally by the quality and quantity of flour which Indian wheats would yield, but if on other points a red wheat and a white wheat were equal the preference would be given to the white wheat.

Each of the 10 samples was noteworthy free from dirt and extraneous matter. The arrangements arrived at by the joint action of shippers, the leading British Corn Trade Association and the Association of British and Irish Millers have brought about a great improvement on this point in the recent shipments of Indian wheat, and if it be possible to ship wheat as "clean" as the 10 samples I have received the relative value of Indian wheats would be still further enhanced.

As part of the process of cleaning wheat by washing, and to prevent as far as possible the pulverizing of the husk in grinding and so secure a better separation of husk from kernel, it is the custom of British millers to "condition" their wheats.

The most important point in the conditioning is the adjustment of the moistures immediately prior to grinding, so that wheats with high moistures would be dried and wheats with low natural moistures would be damped. Of course this means that practically all Indian wheats would be damped and that the driest would be worth more to the miller than those with higher moistures. Incidentally I should like to mention the belief entertained here that some parcels of Indian wheat are artificially damped before shipment. Any such action is unwise from the Indian point of view. It is risky as regards the effect on quality; it seems silly to pay railway and ocean freight on water, and any gain so obtained on the first few transactions would be much more than lost in the long run because all British millers of good standing know quite well the moistures of the wheats they receive, that point enters into their calculations to the detriment of sellers on the highest percentage of water the wheats they buy will contain.

The 10 samples were all in the best of condition on arrival.

When water is added in the process of cleaning and conditioning it affects the kernel as well as the husk and all varieties of wheat are not affected alike. Some remain "free grinding," that is to say, the kernel when pulverized makes lively granular flour which can be separated from the husk with a minimum of trouble to the miller, others become

"woolly" in texture, the flour is less granular and the separations in the mill are made with difficulty.

The 10 samples show a striking difference in this respect. For free grinding Pusa 6 is very good indeed, Australian 27 poor. The Muzaffernagars are also poor in this respect, and of the three the one grown at Lyallpur is the worst. The five sorts not specifically mentioned in this connection are good as regards this characteristic.

There are very great differences in the hue of the flours from the 10 samples. The three Muzaffernagars all yield flour very white in hue. Of the three, that grown at Muzaffernagar is the whitest, that grown in Pusa is substantially the same, whilst the Lyallpur lot of this variety has a comparatively dingy hue. I think this is associated with the "wooliness" I have mentioned, because to get a commercially complete separation of husk from kernel more force in grinding has to be used and more of the husk accordingly gets pulverized in the grinding. The Australian 27 yields also a white flour. Punjab Type 9 yields a bright but very yellow flour. Gujar Khan one that is yellow in slightly lesser degree. Pusa 6 is as regards colour in a class by itself for its very lively granular flour is neither white, of chalky hue, nor yellow, but a greyish white which I associate with Canadian Fife wheat. Of the other 3 sorts not specifically mentioned in this paragraph, Punjab Type 16 yields flour of very good appearance as regards hue, medium between the chalky white of the Muzaffernagar and the yellows of the Punjab Type 9 and Gujar Khan. A large number of British millers use artificial bleaching and in their hands the two last named would give good results as to colour. In some parts of England and in Ireland, flour of chalky white hue is required, and for those purposes, the sorts yielding such flour might be preferred, but my own preference as to colour would be Pusa 6 or Lal Kasar Wala, and this I think would be the verdict of most English millers.

There are great differences between the 10 as regards strength by which I mean the capacity for making large shapely loaves. On this point Pusa 6 is pre-eminent. The loaves are not only larger, but whereas those from all other flours have the appearance typical of Indian varieties, those from Pusa 6 have a quite different and a superior crust and general appearance. Gujar Khan, Punjab Type 9 and Lal Kasar Wala are not behind so far as size of loaf is concerned. Of the three Muzaffernagars the Pusa lot is distinctly the best, the Muzaffernagar distinctly the

worst, the Lyallpur lot occupies the middle position. The Punjab Types 14 and 16 and Australian 27, are only poor on this point.

As regards the stability of dough in baking all are good. Pusa 6 is the nearest approach to the toughness which is associated with Canadian or American Spring wheats, but that is not to be compared with those sorts, nor should I expect to find any wheats behaving in that way unless with great summer heat a high summer rainfall be associated.

In summarizing the foregoing, I unhesitatingly express the opinion that Pusa 6 is the best and I can quite as unhesitatingly say, I do not like Australian 27 or Muzaffernagar grown at Muzaffernagar. There is a growing inclination amongst grain merchants to mix their wheats so as to reduce the number of grades in which they deal. No particular harm would be done if they mixed as follows :—

- |    |   |
|----|---|
|    | { Muzaffernagar grown at Muzaffernagar. |
| A. | { " " Lyallpur.                         |
|    | { " " Pusa.                             |
|    | { Australian 27.                        |
| B. | { Lal Kasar Wala.                       |
|    | { Punjab Type 16.                       |
| C. | { Punjab Type 9.                        |
|    | { Gujar Khan.                           |

Punjab Type 14 might be grouped with C, but would be better handled separately. Pusa 6 might be grouped with B, but would make most money if sold by itself, on its own sample or reputation. Group A should not be mixed with either B or C, nor should any individual of the group A be mixed with groups B or C. If group B were mixed with group C, no particular harm would be done, but they are better apart.

Different millers may have different opinions about the same wheat, and as indicated herein some sorts may have special values in different localities, but as a miller trading in the London district, I should put the 10 in the following order having regard to all the points mentioned :—

1. Pusa 6.
2. Lal Kasar Wala.
3. Punjab Type 9.
4. Gujar Khan.
5. Muzaffernagar grown at Pusa.
6. Punjab Type 16.
7. " " 14.

8. Muzaffernagar grown at Lyallpur.
9.       "                       "       Muzaffernagar.
10. Australian 27.

I find great difficulty in answering your question as to the relative money values of these 10 Indian wheats and Canadian and American grades. Canada and the United States of America grow some poor weak wheats, and I would certainly pay as high or even a higher price for any of the 10 as I would for Canadian Redwinters, or for the wheats grown on the Pacific slope of the United States of America or for most of the United States winter wheats shipped as they are with all their uncertainties as to grading but these Indians are quite different to Canadian or United States of America spring wheats, and are not comparable with them. So long as the world grows so much more weak wheat than strong wheat, and so long as millers are compelled to supply flours of good or great strength, wheats capable of yielding flour from which tough, stable doughs and big loaves can be made will command a large premium.

Some authorities measure strength by the number of loaves a given quantity of flour produce but a reliable opinion cannot be formed on this point on small lots such as you sent me. It is, however, quite safe to say that the better of your 10 would rank high on this point. The relative value of Indian wheats has already gone up a great deal as a result of improved cleaning and greater reliability in quality, and if wheats as good in intrinsic quality, as well grown, as clean and as dry as the first 6 on my last list are shipped here from India the growers can rely on a still farther increase in their relative value in competition with the wheats of the world.

ALBERT E. HUMPHRIES.

---

It will thus be seen from the above report that the four best wheats are hard wheats and that the last two are soft white wheat both of which have been largely distributed to cultivators. In addition, the first four besides being the best for the miller are hard wheats, good yielders with good straw and considerable resistance to rust. Pusa 6 which was selected by us in 1906, and which has been grown from a single plant, is one of the most rust resistant wheats we possess at Pusa and matures well even on second class wheat soil. The samples of Pusa 6

and Muzaffernagar white from Pusa, were grown in 1907-08 on rather light soil and without any irrigation or manure. Moreover they followed Cassava which is regarded as an exhausting crop and which was not taken off before the monsoon of 1907 had well set in. The land therefore did not even get the usual preparation for wheat. These samples therefore owe nothing either to soil, cultivation or manuring.

It is interesting to compare the nitrogen content of these wheats with the miller's report. The nitrogen determinations were kindly made for us by Dr. J. W. Leather, Imperial Agricultural Chemist, and we take this opportunity of expressing our indebtedness to him for the work.

Order of value from the milling and baking standpoint. (Humphries)	Order as regards % of nitrogen. (Leather.)	% Nitrogen.
1. Pusa 6 . . . . .	1. Pusa 6 . . . . .	2.52
2. Lal Kasar Wala . . . . .	2. Punjab Type 9 . . . . .	2.01
3. { Punjab Type 9 . . . . .	3. Muzaffernagar grown at Pusa . . . . .	1.86
{ Gujar Khan . . . . .		
5. Muzaffernagar grown at Pusa . . . . .	4. Gujar Khan . . . . .	1.76
6. Punjab Type 16 . . . . .	5. Muzaffernagar grown at Lyallpur.	1.65
7. " " 14 . . . . .	6. Punjab Type 16 . . . . .	1.39
8. Muzaffernagar grown at Lyallpur.	7. " " 14 . . . . .	1.37
9. { Muzaffernagar grown at Muzaffernagar.	8. Muzaffernagar grown at Muzaffernagar.	1.34
{ Australian 27 . . . . .	Australian 27 and Lal Kasar Wala were not analysed.	

It will be seen that the order of the baking value and of nitrogen content is practically the same in both cases thereby confirming the work of Hall who has recently made a critical study of the relations between composition and strength in wheats and who concludes that, as a rule, the order of strength and of total nitrogen closely correspond.<sup>1</sup>

<sup>1</sup> Hall, A. D.—The question of quality in Wheat—*Journal of the Board of Agriculture* (England), Volume XI, No. 6.

It will be further remarked that the Muzaffernagar wheat grown at Pusa stands higher in nitrogen and in baking value than the same variety grown at Lyallpur and at Muzaffernagar. Moreover the Pusa grown sample was not entirely soft white but contained a fair proportion of hard and semi-hard grains. We have frequently noticed the effect of soil and climate on consistency in wheats in India and have come to the conclusion that hardness and softness are characters of no systematic value. A full discussion on this subject will be found in a subsequent paper. We believe that for purpose of seed distribution, India will have to be divided up into hard and soft wheat tracts and from our observations on the wheats at Lyallpur we think the Canal Colonies of the Panjab are not likely to be the best tracts for the growth of hard wheats. There seems to be a tendency under canal irrigation to produce wheats very variable in consistency, which is a drawback for proper grading and from the point of view of the home miller who desires to have wheat uniform in texture.

In conclusion, we would emphasise the point that both the Indian and the English consumer prefer hard wheats, whether red or white, and that the demands of the local and export trade are identical. The growth of weak soft white wheats for export trade we consider to be a mistake and that when the English millers realise that India can produce much stronger wheats than those at present exported, the growth of the weak soft white wheats like Muzaffernagar will be given up and the harder and more easily cultivated stronger flinty wheats will take their place. The hard wheats referred to in this paper by no means exhaust the stronger sorts we now have in cultivation. A number of others have been isolated by us in pure culture which we propose to test next year. At present, the seed of these varieties at our disposal is too small for a proper milling or baking test.

and Muzaffernagar white from Pusa, were grown in 1907-08 on rather light soil and without any irrigation or manure. Moreover they followed Cassava which is regarded as an exhausting crop and which was not taken off before the monsoon of 1907 had well set in. The land therefore did not even get the usual preparation for wheat. These samples therefore owe nothing either to soil, cultivation or manuring.

It is interesting to compare the nitrogen content of these wheats with the miller's report. The nitrogen determinations were kindly made for us by Dr. J. W. Leather, Imperial Agricultural Chemist, and we take this opportunity of expressing our indebtedness to him for the work.

Order of value from the milling and baking standpoint. (Humphries)	Order as regards % of nitrogen. (Leather.)	% Nitrogen.
1. Pusa 6 . . . . .	1. Pusa 6 . . . . .	2.52
2. Lal Kasar Wala . . . . .	2. Punjab Type 9 . . . . .	2.01
3. { Punjab Type 9 . . . . .	3. Muzaffernagar grown at Pusa . . . . .	1.86
{ Gujar Khan . . . . .		
5. Muzaffernagar grown at Pusa . . . . .	4. Gujar Khan . . . . .	1.76
6. Punjab Type 16 . . . . .	5. Muzaffernagar grown at Lyallpur. . . . .	1.45
7. " " 14 . . . . .	6. Punjab Type 16 . . . . .	1.39
8. Muzaffernagar grown at Lyallpur. . . . .	7. " " 14 . . . . .	1.37
9. { Muzaffernagar grown at Muzaffernagar. . . . .	8. Muzaffernagar grown at Muzaffernagar. . . . .	1.34
{ Australian 27 . . . . .	Australian 27 and Lal Kasar Wala were not analysed.	

It will be seen that the order of the baking value and of nitrogen content is practically the same in both cases thereby confirming the work of Hall who has recently made a critical study of the relations between composition and strength in wheats and who concludes that, as a rule, the order of strength and of total nitrogen closely correspond.<sup>1</sup>

<sup>1</sup> Hall, A. D.—The question of quality in Wheat—*Journal of the Board of Agriculture* (England), Volume XI, No. 6.

It will be further remarked that the Muzaffernagar wheat grown at Pusa stands higher in nitrogen and in baking value than the same variety grown at Lyallpur and at Muzaffernagar. Moreover the Pusa grown sample was not entirely soft white but contained a fair proportion of hard and semi-hard grains. We have frequently noticed the effect of soil and climate on consistency in wheats in India and have come to the conclusion that hardness and softness are characters of no systematic value. A full discussion on this subject will be found in a subsequent paper. We believe that for purpose of seed distribution, India will have to be divided up into hard and soft wheat tracts and from our observations on the wheats at Lyallpur we think the Canal Colonies of the Punjab are not likely to be the best tracts for the growth of hard wheats. There seems to be a tendency under canal irrigation to produce wheats very variable in consistency, which is a drawback for proper grading and from the point of view of the home miller who desires to have wheat uniform in texture.

In conclusion, we would emphasise the point that both the Indian and the English consumer prefer hard wheats, whether red or white, and that the demands of the local and export trade are identical. The growth of weak soft white wheats for export trade we consider to be a mistake and that when the English millers realise that India can produce much stronger wheats than those at present exported, the growth of the weak soft white wheats like Muzaffernagar will be given up and the hardier and more easily cultivated stronger flinty wheats will take their place. The hard wheats referred to in this paper by no means exhaust the stronger sorts we now have in cultivation. A number of others have been isolated by us in pure culture which we propose to test next year. At present, the seed of these varieties at our disposal is too small for a proper milling or baking test.



CALCUTTA  
SUPERINTENDENT GOVERNMENT PRINTING, INDIA  
3, HASTINGS STREET

